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REVIEWS

Aerodynamic Drag Mechanisms of Bluff Bodies and Road Vehicles. Edited by G. SOVRAN, T. MOREL and W. T. MASON. Plenum Press, 1978. 380 pp. $47.40.

This is the proceedings of a Symposium, held at the General Motors Research Laboratories in September 1976. It contains full reports of 10 presented papers, together with some shorter contributions, and reports of panel sessions. Each paper is followed by formal discussion. Although the editors claim that 'verbatim transcripts were not necessarily used', the style of the discussion reports gives the appearance of off-the-cuff remarks.

Proceedings of meetings such as this have a rather special place in the range of published material on library shelves. Much of what is contained in the formal papers is either a re-hash of previously published work, or a trial run for papers to be submitted later for publication in journals. This does not mean that publication of a volume such as this is not worthwhile. This well-produced and -bound book forms a very useful compendium of information on a specific topic, collecting together ideas which would inevitably otherwise be scattered in the literature. The book will be especially valuable for those just commencing research, such as graduate students, and also for those seeking to broaden their research interests.

The aim of the present symposium was to bring together academic aerodynamicists, whose interests are not primarily related to road vehicles (for example, typical readers of this journal!), and practising automobile-industry people, whose concern is with little else. The topic was almost entirely restricted to that of *drag*, as distinct from other more general aerodynamic matters.

Among the formal papers, there are three by authors from the automobile industry, the rest being by authors with a university address, and there is little in common between the two sets of papers. This reviewer found the non-academic papers considerably more interesting than the academic ones, although this may have been, in part, because the style was refreshingly different. In particular, the lead-off paper, by W.-H. Hucho, from Volkswagen, is an excellent review of the state of the art for car aerodynamics.

An example of an important consideration for conventional small passenger cars, identified by Hucho, and amplified in other papers and discussions, concerns the 'fastback–squareback' cross-over, in design of the rear end. The controlling parameter is the rear-deck angle; low angles (to the horizontal) give a fastback, with delayed separation, and high angles a squareback, with early separation. Both forms can be desirable, in the sense of allowing low-drag designs, whereas the neighbourhood of the cross-over point (in a narrow range centred about 30° for some typical vehicles) leads to high drag. The nature of the three-dimensional flow changes that take place through this cross-over regime is discussed, but seems still not to be well understood.

Another important theme of the symposium is the optimization of combination vehicles, such as trucks and trailers, so as to minimize the drag. Some quite impressive drag reductions are obtainable, by careful choice of the gap between the two vehicles, combined with smoothing of corners, etc. There are both academic (idealized

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geometry) and practical (actual truck-trailer models) papers in the volume on this topic. Again, there is incomplete theoretical understanding of the reasons for this success.

The book also includes two papers bearing upon attempts to solve aerodynamic problems by purely computational means. The conclusion is the usual pessimistic one, although the authors are somewhat less pessimistic than their discussers.

In the final analysis, it is the discussion that stands out, and makes the book worthwhile. One topic to which discussers (particularly R. T. Jones, whose frequent brief contributions are uniformly enlightening and refreshing) turn often, is the relationship between induced drag and lift. Aerodynamicists are used to this relationship being inevitable, as it is normally for wings, but for ground vehicles it is entirely possible to have one without the other. The reports of discussions on this and several other issues are lively, and suggest that the symposium must have been an exciting and enjoyable experience for those attending it. Those who did not, can capture some of this flavour by reading this volume.

E. O. TUCK

An Introduction to Hydrodynamics and Water Waves. By B. LE MÉHAUTÉ. Springer, 1976. 323 pp. $24.80.

When this book reached me, after an appreciable delay, I looked forward to finding a text-book which might give an up-to-date introduction to the subject of water waves. The fact that the book appears to start by introducing hydrodynamics seemed a good omen since it should ensure that any student would find the appropriate background material at hand in the same volume. The book is divided into three parts. The first part 'Establishing the basic equations that govern flow motion' introduces the equations of motion. These sections have a somewhat antiquarian feeling since the author prefers to write out three component equations rather than expect the student to have mastered vectors. However, the 'square' format of the pages (220 × 233 mm) and the good work of his publisher mean that the text does not become any less easy to read. Indeed, for engineers trained over 30 years ago the slight use of vectors could be an advantage. A good feature of this part is that, immediately after the Navier–Stokes equations are introduced, two chapters are devoted to turbulent flow. The first carefully introduces Reynolds equations for the mean flow, the second discusses some effects of the turbulence. This part concludes with a chapter on flow in a porous medium.

Part two, 'Some mathematical treatments of the basic equations', gives a very full account of Bernoulli's equation and a discussion of potential flows followed by the use of control volumes and momentum conservation to analyse flows. This last chapter has a feature that should appear more frequently in text books – a discussion of examples where its application is *not* successful. The remaining topics of this part are boundary-layers, flow in pipes, drag, added mass and open-channel hydraulics.

The final part brings us to water waves. After an introductory chapter, a relatively full account of linear water waves is given. The next chapter, on finite amplitude waves, is more like a survey since the author considers 'the mathematical details to be beyond the scope of this book'. However, finite-amplitude long waves are considered in more detail in the final chapter which also includes a short account of numerical methods of integrating the one-dimensional equations. There are

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appendices on 'Wave motion as a random process' and 'Similitude and scale model technology'.

Unfortunately, despite its attractive appearance and good choice of topics this book cannot be recommended as a text book either for a student or for a mature person seeking to learn more of these topics. First of all the author assumes 'some notion of elementary hydraulics', yet consideration of the words and ideas that the author presupposes known at various points throughout the book shows that a moderately wide acquaintance with that subject is desirable. The contrast with the modest mathematical requirements, e.g. on Kelvin's circulation theorem for which it is stated that 'an exact demonstration ... is beyond the scope of this book', makes one feel that the book is really aimed at the 'practicing engineer who wants to improve his theoretical background'. However, even he will need to treat the book with caution because of its numerous errors.

I feel somewhat sympathetic to one of the worst errors – the treatment of added mass. The fact that it is not as straightforward as it appears at first sight only occurred to me while delivering a lecture on the subject. However, this book is in print. The added mass for a circular cylinder is derived in three ways, the first is correct, the second and third are incorrect and the answer is incorrect in the third case. The author omits to note that for a moving cylinder the evaluation of $\partial\phi/\partial t$ must be *on* the moving cylinder, and that if a fluid is accelerating *either* there is a corresponding pressure gradient causing the acceleration and hence leading to a force on the body *or* the fluid is being observed from an accelerated frame of reference in which case there is an acceleration field to be introduced. Another unfortunate part is the subsection headed 'The natural tendency for fluid flow to be unstable' where a quite invalid argument indicates that any flow is unstable in the absence of viscosity. Other errors tend to be more in the nature of approximate statements which are given as exact. These stand out since in many other cases the author is careful to explain the applicability of various equations.

One would hope that the final part, on water waves, might still provide a useful guide to the subject. However this is not so. A large number of different 'theories' are mentioned but the differences between them are not properly discussed. One of the major differences between authors is the initial choice of reference frame for the wave. Stokes discussed this and gave the two most common examples: that frame in which the mean velocity at a point beneath a wave trough is zero; and that in which the mass transport of the waves is zero. Le Méhauté is aware of mass transport but seems to think it is directly related to vorticity! The implications of Kelvin's circulation theorem seem to have escaped his notice. Figure 17.6 presents seven different theoretical wave profiles in comparison with an experimental profile, but it is immediately apparent that at least two of the profiles are for a completely different mean level, so what is one to make of it! Other faults such as changing from $V = \text{grad}\,\phi$ in parts 1 and 2 to $V = -\text{grad}\,\phi$ in part 3 and describing linearization of the boundary conditions for infinitesimal waves as 'the case of slow motion' are minor irritations by comparison.

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SHORTER NOTICES

Les Instabilités Hydrodynamiques en Convection Libre, Forcé et Mixte. Edité par JEAN-CLAUDE LEGROS et JEAN KARL PLATTEN. Lecture Notes in Physics, vol. 72, Springer 1978. 202 pp. $12.40.

Ce livre constitue le compte rendu d'un colloque réuni a l'Ecole de Thermodynamique de Bruxelles en avril 1977. Il contient dix-huit articles sur des problèmes variés posés par la convection thermique, la plupart concernant les conditions au voisinage du point d'instabilité. Les situations plus compliquées du problème Rayleigh–Bénard sont discutées: action d'un champ magnétique ou électrique, de la rotation, effet Soret et effet Dufour, par exemple. On y trouve aussi des discussions sur l'instabilité des nématiques et des liquides viscoélastiques. L'ouvrage est une collection d'articles qui décrivent les travaux récents. Quelques uns des resultats sont déjà publiés, quelques autres seront sans doute publiés ailleurs avec plus de détails. Mais pendant quelques années ce livre intéressera les spécialistes qui voudront connaître les directions dans lesquelles progressent les travaux dans ce domaine.

Studies in Convection. Volume 2. Edited by B. E. LAUNDER. Academic Press, 1977. 223 pp. £8.80.

This book is called 'Studies in Convection. Theory, Measurement and Applications. Volume 2' on the jacket, and 'Studies in Convection. Volume 2. Theory, Measurement and Applications' on the title-page. The jacket is correct; 'Theory, Measurement and Applications' is not the specific title of this second volume of a series. It does not appear to have a specific title, but in fact is about aspects of convection relating to chemical reaction and combustion. The word 'convection', incidentally, is used here in the sense of what used to be called 'forced convection'. The scope of the series is defined on the jacket as 'convective transport processes', which properly speaking embraces most of fluid mechanics but which here means mixing and transport in turbulent internal flow systems of interest to mechanical engineers.

With that etymological guidance readers will be interested to know that the book contains the following four articles.

Studies in variable-density and reacting turbulent shear flows, by P. A. Libby (43 pp.).

Mixing, concentration fluctuations, and marker nephelometry, by H. A. Becker (95 pp.).

Studies in the prediction of turbulent diffusion flames, by S. Elghobashi (49 pp.).

Calculation of chemically reacting flows with complex chemistry, by D. T. Pratt (30 pp.).

The last two articles are concerned with computational schemes. The two by Libby and by Becker are of more direct fluid-mechanical interest; and both are informative. I should add, in H. A. Becker's own words, that 'marker nephelometry is the technique of studying concentration fields associated with processes of mixing and dilation (dilatation?) by marking one or more of the feed-streams to a field with particles, and detecting particle concentrations by means of an optical probe based on

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light scatter principles'. It seems a nice idea, with considerable potential in these days of sophisticated optical laboratory instruments. Becker gives a comprehensive account of the technique, both the theory and the practice.

Rolling Contact Fatigue: Performance Testing of Lubricants. Edited by R. TOURRET and E. P. WRIGHT. Heyden & Son Inc., 1977. 308 pp. £18.00.

The pits which form in surfaces subjected to repeated rolling contact loads have traditionally been thought to develop by the propagation of fatigue cracks from subsurface flaws in the material – usually hard steel. It is inconceivable that such a mechanism of failure could be affected by the lubricant at the surface. However, improved steel-making processes have revealed an alternative mode of failure in which fatigue cracks propagate from discontinuities in the surface. In this mode the fatigue life is strongly influenced by the lubricant; physical properties such as viscosity control the thickness of the lubricant film and its penetration into cracks. Chemical properties influence the propagation rate, particularly in the case of water-based fire-resistant fluids. The present book records the proceedings of a symposium arranged by the Institute of Petroleum on fatigue-testing equipment and the interpretation of test data. It contains 17 papers: 11 devoted to test methods and apparatus, and the remainder to results obtained mainly with fire-resistant fluids. It is a valuable reference book for anyone concerned with rolling-contact fatigue testing.

The Proceedings. Second International Conference on Numerical Ship Hydrodynamics. Edited by JOHN V. WEHAUSEN and NILS SALVESEN. University Extension Publications, Berkeley, 1977. 399 pp. $20.00 (student price $10.00).

Thirty papers are included in this attractive volume. The principal topics are wave resistance, surface-wave radiation and diffraction, and cavity flows. A broad perspective is provided by two survey articles, on numerical solutions for ship free-surface problems (R. B. Chapman) and on three-dimensional cavity-flow problems (R. L. Street). The remaining papers cover a variety of specialized problems, including some nonlinear or three-dimensional solutions. With only one exception these are inviscid. From the mathematical viewpoint the contributions are divided fairly evenly between those which utilize classical techniques of potential theory to the maximum extent before resorting to numerical analysis, and those where the fluid domain is discretized at the outset. These alternative approaches appear equally fruitful in the present stage of this field.

Conference on The Evaluation and Calibration of Ultrasonic Transducers (London 11–12 May 1977). IPC Science and Technology Press Ltd. 1978. 139 pp. £16.00.

These conference proceedings contain a mixture of papers contributed by workers in medical ultrasonics and non-destructive testing covering research in transducer techniques and their practical applications. Simplified methods for the testing and calibration of transducers comprise about half the papers since such methods are

important in medical practice. Some more exact calibration methods based on laser interferometer techniques are also described, as well as calorimetric methods for measuring transducer acoustic power. There are a few theoretical papers chiefly concerned with predicting the shape of the acoustic field and its frequency description when the transducer is excited by a pulse. Finally, a brief outline is given of the programme of research in ultrasonics drawn up for the European Economic Community (EEC).

Strömungsmechanik. Volume 1. By E. LEITER. Vieweg, 1978. 158 pp.

This paperback text is the first volume of a two-volume elementary introduction to fluid mechanics for students of mechanical and electrical engineering or physics. The topic selection and structure are based on lectures given by Professor Oswatitsch, and a full list of books for further reading is included. The bulk of the book is concerned with one-dimensional steady flow, including shock waves and effects of friction and heat transfer. A short section gives brief examples of momentum and energy relations for sudden area changes, jet propulsion, etc., and the last 30 pages deal with one-dimensional unsteady wave propagation based on the characteristic and shock wave relations. The book gives a firm foundation for further study and would in fact be equally suitable as the basis for a first-year aeronautical engineering course in fluid mechanics and gas dynamics, although most lecturers would probably want to supplement the text with simple examples of experimental results.